QUANTITATIVE MEASUREMENT OF THE RIGHT INTERNAL JUGULAR VEIN DIAMETER BY ULTRASOUND IMAGING IN DIFFERENT POSITIONS

A

Dissertation

Submitted in partial fulfillment of

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CERTIFICATE

This to certify that this dissertation entitled **"QUANTITATIVE MEASUREMENT OF THE RIGHT INTERNAL JUGULAR VEIN DIAMETER BY ULTRASOUND IMAGING IN DIFFERENT POSITIONS"** is a bonafide work done by **Dr. S.Shenbagarajan** in partial fulfillment of the rules and regulations for the degree M.D Branch x in Anaesthesiology examination to be held in March/April 2007 by the Tamilnadu Dr. M.G.R Medical University, Chennai.

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I would like to thank all my department colleagues who volunteered for this study and finally I wish to thank God for enabling me to complete this study.

CONTENTS

AIM

1. **To determine whether alteration in patient position affects the diameter of the internal jugular vein and the relationship of the vein to the carotid artery.**

2. **As an extension of the study, it was decided to asses how the height, weight, neck circumference and sterno-hyoid distance correlate with the diameter of the internal jugular vein.**

INTRODUCTION

The right internal jugular vein (IJV) is one of the commonest routes for central venous cannulation. The success and ease of the cannulation correlates with the diameter of the vein. It can be concluded that the larger the diameter of the IJV, the easier and quicker it is to perform cannulation.(1,10)

There are different ways to position the patient for the cannulation. Different positions affect the diameter of the internal jugular vein differently (1,2,4,12,14). One of the popular methods is the central approach described by DAILY and colleagues(5).This central approach is usually combined with the placement of a folded sheet under the shoulders, head turned to contralateral side completely and a finger on the carotid pulse. This conventional position and approach has been reported to result in a decrease of the diameter of the IJV.(1)

A modified position in which, there is no folded sheet under the shoulders, flexion of the neck with pillow under the head and not palpating the carotid artery, is more likely to result in increase in the diameter of the internal jugular vein(1). This inturn can increase the success rate of quick and first pass cannulation as well as decrease the incidence of carotid artery puncture.

In this study, it is proposed to quantitatively measure the diameter of the IJV with ultrasound imaging in both (1) the conventional position and (2) the modified position and to determine whether there is a significant difference.

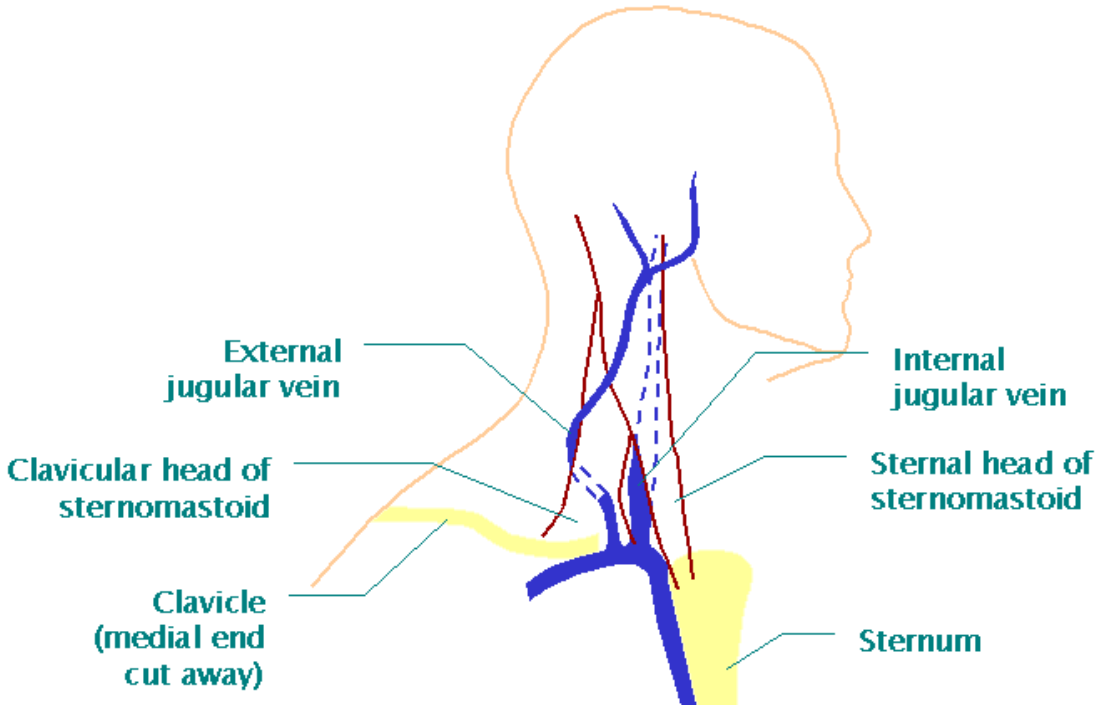
As an extension of the study, the correlation between the weight, height, neck circumference and the sterno hyoid distance on the one hand and the diameter of the IJV on the other was also studied

REVIEW

OF

LITERATURE

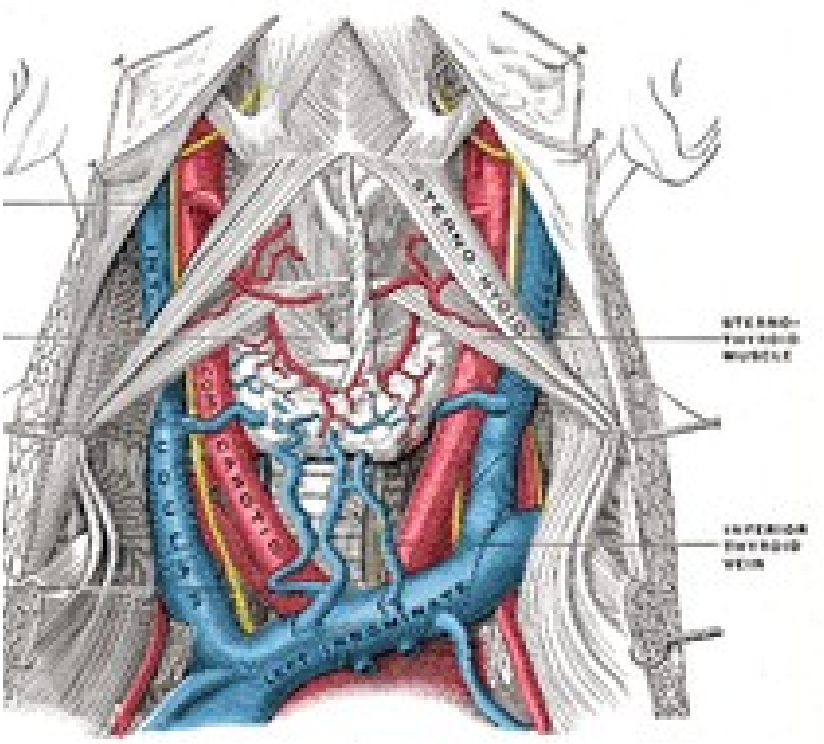
FIGURE 1


External jugular vein
Clavicular head of sternomastoid
Clavicle (medial end cut away)
Internal jugular vein
Sternal head of sternomastoid
Sternum

ANATOMY OF THE INTERNAL JUGULAR VEIN

The internal jugular vein begins at the cranial base in the posterior compartment of the jugular foramen, continuous with the sigmoid sinus. At its origin is its superior bulb, which is below the posterior part of the tympanic floor. The vein descends in the carotid sheath uniting with the subclavian vein, posterior to the sternal end of the clavicle to form the brachiocephalic vein. Posterior to the vein, from above are: the rectus capitis lateralis, cervical plexus, scalenus anterior, phrenic nerve, thyrocervical trunk, vertebral vein and the first part of the subclavian artery. On the left, it crosses anterior to the thoracic duct. Medial to the vein are the internal and common carotid arteries and the vagus nerve lies between arteries and vein, but posterior to them. Superficially the vein is overlapped above, then covered below by sternocleidomastoid and crossed by the posterior belly of the digastric and the superior belly of the omohyoid. The internal jugular vein lies in the groove between the sternal and clavicular heads of the sternocleidomastoid muscle, lateral and slightly anterior to the carotid artery. The vein is represented on the surface by a broad band connecting the ear lobule to the medial end of the clavicle. Anatomic land marks for the cannulation are sternal notch, clavicle and sternocleidomastoid muscle (5,6,7).

FIGURE 2


STERNO-HYOID
STERNO-THYROID MUSCLE
CAROTID
INFERIOR THYROID VEIN

Cannulation of the internal jugular vein was first described by English et al in 1969. Its popularity among anaesthesiologists has steadily increased since that time. Advantages of this technique include (1) the high success rate as a result of the usually constant relationship of the anatomic structures;(2) a short, straight course to the right atrium(RA) that almost always assures RA or superior vena cava(SVC) localization of the catheter tip;(3) easy access from the head of the operating room table; (4) fewer complications than the subclavian vein catheterization.

The right internal jugular vein is preferred over the left, since this vein leads straight into the SVC, the right cupula of the lung is lower than the left, and the thoracic duct is on the left side(8,9).

INDICATIONS FOR CENTRAL VENOUS CANNULATION (5,8,9)

Central venous pressure monitoring

Pulmonary artery catheterization and monitoring

Transvenous cardiac pacing

Temporary haemodialysis

Drug administration

Vasoactive drugs

Hyperalimentation

Chemotherapy

Drugs irritating to peripheral veins

Prolonged antibiotic therapy

Rapid infusion of fluids

Trauma

Major surgery

Aspiration of emboli

Inadequate peripheral venous access

Sampling site for repeated blood testing

CONDRAINDICATIONS FOR CENTRAL VENOUS CANNULATION (5,8,9)

SVC syndrome

Renal cell tumor extending in to the right atrium

Fungating tricuspid valve vegetations

Patients on anticoagulants

Patients with bleeding disorders

Presence of carotid disease

Recent internal jugular vein cannulation (with the concomitant risk of thrombosis)

Contralateral diaphragmatic dysfunction

Thyromegaly or prior neck surgery

Patients who had an ipsilateral carotid endarterectomy

SITES FOR INTERNAL JUGULAR VEIN CANNULATION (9)

APPROACHES	LANDMARKS
Central	Apex of triangle formed by lateral (clavicular) and medial (sternal) head of sternocleidomastoid. Aim needle caudally and laterally toward ipsilateral nipple
Posterior	Intersection of lateral border of lateral (clavicular) head of sternocleidomastoid and line drawn laterally from cricoid ring. Aim needle caudally and ventrally (anteriorly) toward sternal notch
Anterior	Medial border of medial head, 5 cm above clavicle. Direct toward ipsilateral nipple

Supraclavicular	Interscalene groove, 2 cm above clavicle. Directed caudally and medially

COMPLICATIONS OF IJV CANNULATION DEPENDING ON APPROACH (9)

APPROACHES	COMPLICATIONS
Central	Low incidence of pneumothorax; hemothorax; medial direction has higher incidence of carotid puncture
Posterior	Higher incidence of carotid puncture; low incidence pneumothorax; hemothorax
Anterior	Carotid puncture more likely unless retracted medially; hemothorax
Supraclavicular	Higher chances of pnemothorax, subclavian artery puncture; hemothorax

COMPLICATIONS COMMON TO CENTRAL VENOUS

CANNULATION(5,8,9,15,16)

Mechanical

Vascular injury

- Arterial
- Venous
- Cardiac tamponade

Respiratory compromise

Airway compression from hematoma

Pneumothorax

Nerve injury

Thromboembolic

Venous thrombosis

Pulmonary embolism

Arterial thrombosis and embolism

Catheter or guidewire embolism

Venous air embolism

(Contd…)

12

(Contd…)

Transient atrial and / or ventricular arrhythmias

Complete heart block

Infectious

Insertion site infection

Catheter infection

Bloodstream infections

Endocarditis

Many different techniques for internal jugular vein cannulation have been described. Careful positioning will make the patient comfortable, improve identification of surface landmarks, and increase the likelihood of successful cannulation. The central approach described by DAILY and colleagues is among the most popular. In this approach the patient is placed in the supine position with head turned slightly to the left to expose the right side of the neck and keep the chin away from interfering with the procedure. Pillows that cause the neck to be flexed should be removed, but forceful neck extension or extreme leftward rotation of the head is avoided .

Dr. Gareth Parry, Department of Anaesthetics, University of Wales College of Medicine, Heath Park, United Kingdom in his study tried to find out patient position resulting in the largest right internal jugular vein.

Twenty one anaesthesiologists and recovery room nurses volunteered for the study. They measured the IJV diameter in an anteroposterior plane at the level of the cricoid cartilage. Different body positions were adapted. A second observer palpated the carotid artery with minimum necessary pressure to feel the carotid pulse.

He found that pillow under the head, 15 degrees Trendlenberg tilt increased the diameter of the IJV significantly. Rotation of the head 45 degrees to the left and light palpation of the carotid artery reduced the diameter.

He suggests 15 degrees Trendlenberg tilt with small pillow under the head, the head in or close to the midline, carotid artery palpation released just prior to the needle insertion will have greater IJV diameter(1).

Another important study which also has relevance to this dissertation is that by Troianos et al which deals with IJV and carotid artery (CA) anatomic relation as determined by ultrasonography.

Cannulation of the IJV using anatomical landmarks is associated with 95% success rate. It shows improved success and fewer complications when ultrasound guidance is used to facilitate cannulation. An anatomic relation in which the IJV overlies the CA has been accounted for unintentional CA puncture. They tried to identify the anatomic relation of the right internal jugular vein and CA in the direction of the cannulating needle using ultrasound imaging.

Awake patients were placed in supine position on a stretcher parallel to the floor without a pillow, and their heads were rotated as far to the left as was comfortable. The IJV was imaged at the apex of the triangle formed by sternocleidomastoid muscle and the clavicle.

Scores of 0-4 were given for no overlap, 25%, >25%, >50%, and >75% overlap of the diameter of the CA respectively.

Fifty four percent of the study population showed a score of 4(>75% overlap). Patients with larger veins had higher scores. There was no correlation between weight, height or age with the vein size.

They demonstrated that overlap was more in older patients. Sulek and colleagues showed greater overlap between the vessels when the head was rotated to 80 degrees compared with 0 and 40 degrees. But in older patients the overlap should be less as they would not be able to rotate their head to the same degree as younger patients. This may be due to the fact that the common CA artery becomes elongated and tortuous in older patients presumably from atherosclerosis.

Sixty percent of their study population had scores of 3 or 4. But the reported CA artery puncture was only 4% rather than 68%. They did not examine the amount of IJV not overlying the CA. The large IJV may overlie the majority of the CA, but in addition extend beyond the lateral edge of the CA. They found that the vein size was positively related to the score, because patients with larger veins tended to have greater scores.

A needle directed toward the position of the vein that does not overlie the CA would have a lower risk of puncturing the CA than a needle directed toward the portion of the vein that overlies the CA. If the cannulating needle enters IJV and is aimed at the CA, entry in to the IJV may be detected before the needle exits the lumen through the posterior wall of the IJV.

They examined the degree of overlap at the level of the apex formed by sternocleidomastoid muscle and the clavicle which is more commonly used for needle insertion. Examination at a different level may have provided more insight into a more optimal approach to the IJV using anatomical landmarks.

They conclude that in a majority of patients, the IJV is not lateral to the CA in an ultrasound imaging plane positioned in the direction of the cannulating needle. Instead, the IJV overlies the CA in 54% of patients overall, predisposing these patients to CA puncture if the cannulating needle traverses the IJV.(21).

The IJV is very compliant that relatively small changes in pressure produce large changes in volume and thus in diameter.

Armstrong showed that maneuvers that increase central venous return increase the IJV diameter. He also found that 15 degrees head down tilt significantly increased IJV diameter, as compared to a flat table. Reduction in the diameter of the IJV occur with any external pressure on the IJV(1). Armstrong showed palpation of the carotid artery significantly reduced the diameter of the IJV. This reduction in the IJV by carotid artery pressure is also seen in the head down tilt position(8)

DOPPLER AND ULTRASOUND

The basis of ultrasound is the conversion of electrical to acoustic energy. Frequencies above 20000 are considered to be in ultrasonic range. The higher frequencies are associated with greater resolution. Ultrasound is an important technique for tomographic imaging of soft tissues. It provides images in real time. As far as it is known, ultrasound at diagnostic intensities does not cause damage to tissues.

Patients readily accept an ultrasound examination because the procedure requires only light pressure on the skin and the preparation is minimal.

Ultrasound is a coherent, mechanical vibration at high frequency. In most diagnostic applications, frequencies in the 2-20 Mhz (millions per second) range are used, corresponding to wavelength of 1-0.1 mm in tissue.

ULTRASOUND TRANSDUCER

Ultrasound is generated by piezoelectric materials. Lead zicornate is the most widely used. The piezoelectric effect derives from the movements of a heavily charged atom that is loosely bound within a complex crystal. When an electric field is applied, the atom moves and distorts the crystal. When electrically pulsed, the crystal rings like a bell at a resonant frequency that is mainly determined by its thickness. Higher frequency crystals are thinner. The piezoelectric effect is symmetrical, so the same or similar crystal is used as a receiver to produce small electrical signals when struck by an ultrasound wave.

Ultrasound is very directional and travels as a narrow beam through the patient's soft tissues as longitudinal waves of alternating compressions and refractions in a straight line.

The crystal is assembled in a conveniently shaped hold which contains the electrodes and any associated electronics, as well as the lenses and matching layers to improve the beam shape. The whole assembly is known as the probe or transducer.

A 2D tomographic ultrasound image is formed by sweeping the beam through a slice of tissue and mapping the echogenicity of the reflectors as shades of grey to form a B mode (B for brightness) scan. This the main mode used for ultrasound imaging. _____

ECHOGENICITY

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Echoes are sound reflections produced by the acoustic interfaces formed between media of differing characteristic acoustic impedances. The prime determinant of the strength of the ultrasonic echoes is the impedence mismatch between the adjacent tissue components. The larger the mismatch the stronger the echo.

SAFETY

An important feature of ultrasound is its apparent safety. This is evidenced by the very many studies that have failed to show any damaging effects of pulsed ultrasound at diagnostic intensities(19,20).

Ultrasound has been used increasingly to identify the anatomic variations of the internal jugular vein. The use of Doppler and ultrasound to assist cannulation of the IJV was reported as early as 1984(17).

Studies have shown that two dimensional ultrasonic guidance of the IJV cannulation is helpful in locating the vein, permits more rapid cannulation and decreases the incidence of arterial puncture(3,11,17,18). Ultrasound has provided more precise data regarding the structural relationship between the IJV and the carotid artery.

Sulek et al observed that there was greater overlap of the IJV and the carotid artery when the head is rotated to 80 degrees compared with head rotation of only 0 to 40 degrees. Therefore excessive rotation of the head can cause distortion of the normal anatomy in a manner that increases the risk of inadvertent carotid artery puncture(13).

Doppler/ultrasound has also been used to demonstrate that the Valsalva maneuver increases the IJV diameter by approximately 25 percent and that the Trendelenberg position increases it by approximately 37 percent(12,14).

Internal jugular vein cannulation with sonographic guidance is more likely to result in success as compared to a blind technique. However, portable sonographic devices are not always available, needs some special training to handle the equipment and sometimes central venous access is difficult to achieve(11).

MATERIALS

AND

METHODS

A pilot study was initially performed to calculate the necessary sample size. Informed consent was obtained from twenty volunteers for the pilot study.

The actual study was performed in healthy volunteers in the radiology department under the supervision of a senior radiologist and anaesthetist.

After getting approval from the hospital research committee, we studied forty volunteers from our medical and para medical colleagues.

All the volunteers were explained to about the procedure and informed consent was obtained.

For the study, the table used was the same as that used for digital substraction angiographic procedures. All the measurements were taken with 5 degrees head down tilt and this was kept constant for all the volunteers.

The materials used for the study were inch tape, weighing machine, pillow routinely used for intubation and folded sheets. The same materials were utilized for all the volunteers.

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The neck circumference was measured at the level of the cricoid cartilage. The sterno hyoid distance was measured from the lower border of the hyoid bone to the upper most palpable border of the sternum with neck in neutral position and the volunteer facing the observer.

A B-mode sonography (Siemens, Adara) with 7-11 MHZ Transducer was used.

The probe was placed horizontally at the level of the cricoid cartilage corresponding to the most frequently used point of needle insertion into the IJV. To standardize the placing of the ultrasound scanner probe, the medial wall of the carotid artery was positioned at the medial end of the screen.

One person palpated the carotid artery in conventional position in all the volunteers to identify the location of the carotid artery. Two fingers were applied over this region taking care not to exert any pressure on the deeper structures.

The largest internal antero-posterior (a in figure 3) and transverse (b in figure 3) diameters of the IJV on the frozen image were taken for measurements in each position.

The depth of the internal jugular vein from the skin was measured from the surface of the skin to the anterior outer wall of the internal jugular vein.

It was planned to measure the distance between the carotid artery and the internal jugular vein in each position. But when the study was performed, it was actually found that the carotid artery was either very close to the internal jugular vein or overlapped by it. So, the portion of the carotid artery overlapped by the internal jugular vein (a in Figure 5) in each position was measured.

CONVENTIONAL POSITION -POSITION (1)

- 5 degree head down tilt
-folded sheet under the shoulder to provide extension
-head turned completely to the contralateral side (leftwards)
-further extension of the cervical vertebrae by removing the intubation pillow
-fingers over the region of the carotid artery region during the measurement

MODIFIED POSITION-POSITION(2)

- 5 degree head down tilt

-no folded sheet under the shoulder

-head turned slightly to the contralateral side (leftwards)

-flexion of the cervical vertebrae by keeping the intubation pillow under the head

To keep the head turn to the opposite side in the modified position, the observer who palpated the carotid pulsation in the conventional position kept his index finger just above the volunteer's left pupil. The volunteer was asked to keep his head in neutral position and then to turn to his left and approximate his nose to the observer' index finger so as to get constant head turn in all the volunteers.

FIRST GROUP

(1)The volunteer was positioned in the conventional position

The anteroposterior, transverse diameters of the Internal jugular vein, the portion of the carotid artery overlapped by the internal jugular vein and the depth of the internal jugular vein from the skin were measured from the frozen ultrasound image.

(2)The volunteer was changed to the modified position

The anteroposterior, transverse diameters of the Internal jugular vein, the portion of the carotid artery overlapped by the internal jugular vein and the depth of the internal jugular vein from the skin were measured from the frozen ultrasound image.

SECOND GROUP

(1)The volunteer was positioned in the modified position.

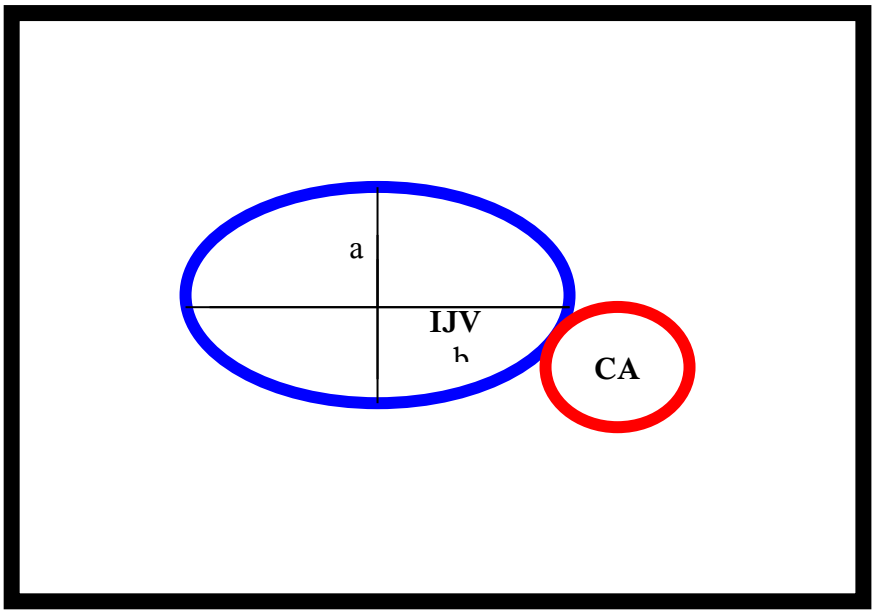
The anteroposterior, transverse diameters of the Internal jugular vein, the portion of the carotid artery overlapped by the internal jugular vein and the depth of the internal jugular vein from the skin were measured from the frozen ultrasound image.

(2)The volunteer was changed to the conventional position.

The anteroposterior, transverse diameters of the Internal jugular vein, the portion of the carotid artery overlapped by the internal jugular vein and the depth of the internal jugular vein from the skin were measured from the frozen ultrasound image.

The data was analysed with the help of the statistician. NPar Tests, Wilcoxon Signed Ranks Test and Pearson's product moment correlations for the analysis were used with SPSS 11.0 Software for windows. The p value of < 0.05 was considered statistically significant.

Figure 3



IJV- INTERNAL JUGULAR VEIN

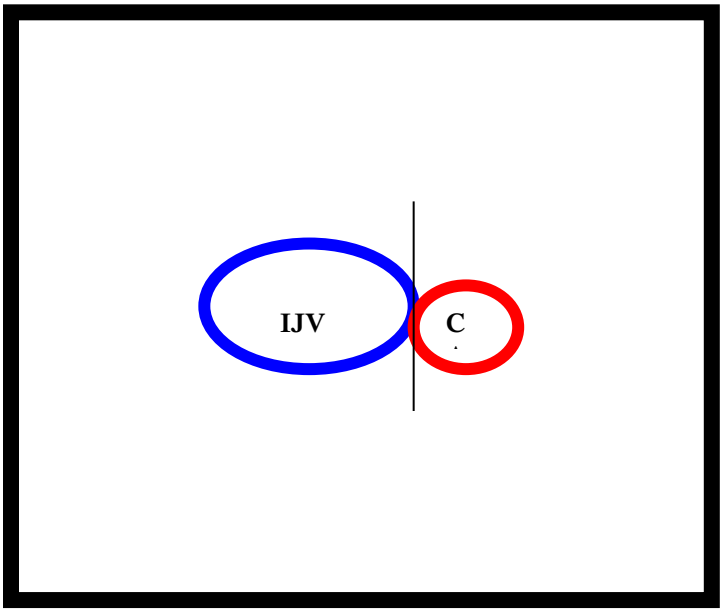
CA- CAROTID ARTERY

a- ANTEROPOSTERIOR DIAMETER

b- TRANSVERSE DIAMETER

31

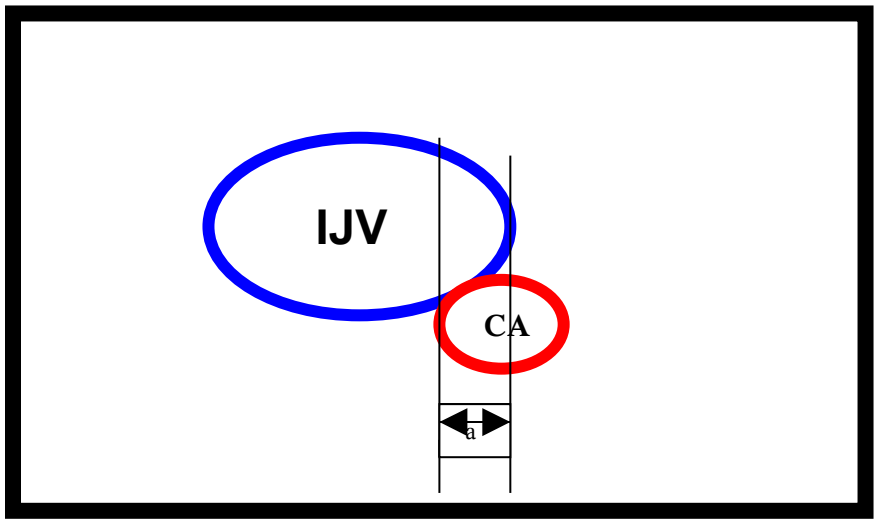
FIGURE 4



IJV- INTERNAL JUGULAR VEIN

CA- CAROTID ARTERY

FIGURE 5



IJV- INTERNAL JUGULAR VEIN

CA- CAROTID ARTERY

a- OVERLAP OF THE CAROTID ARTERY BY THE IJV

RESULTS

AND

ANALYSIS

A total number of forty volunteers were included in this study. The initial twenty volunteers were placed in the conventional position first and then in the modified position. The next twenty volunteers were placed in the modified position first and then in the conventional position.

ANTEROPOSTERIOR DIAMETER OF IJV IN MILLIMETERS(mm)

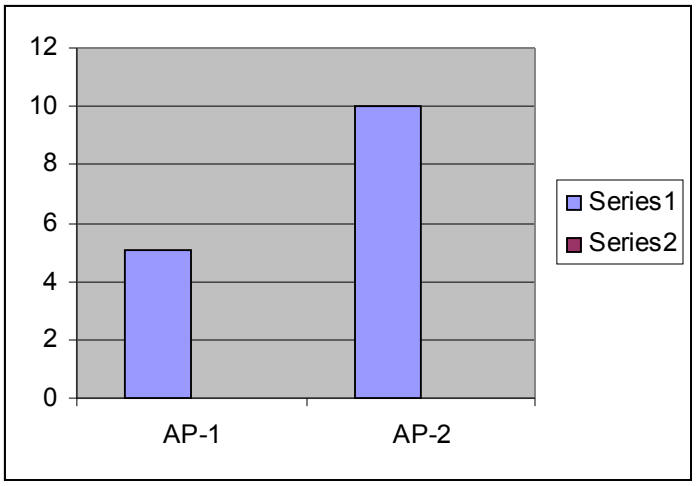
(1) COMPARISION BETWEEN POSITION 1 AND POSITION 2

The mean anteroposterior diameter in position 1 was 5.1 mm (standard deviation of 3.93).The mean in position 2 was 10 mm (standard deviation of 4.69). This difference was statistically significant (P = 0.001)

ANTEROPOSTERIOR DIAMETER OF IJV (AP) IN MILLIMETERS(mm)

(1) **COMPARISION BETWEEN POSITION 1 AND POSITION 2**

(AP-1 AND AP-2)



TRANSVERSE DIAMETER OF IJV IN MILLIMETERS(mm)

(2) COMPARISION BETWEEN POSITION 1 AND POSITION 2

The mean transverse diameter in position 1 was 9.68 mm (standard deviation of 6.11).The mean in position 2 was 14.21 mm (standard deviation

of 5.62).This difference was statistically significant (P value = 0.000)

TRANSVERSE DIAMETER OF IJV IN

MILLIMETERS(mm)

(2) COMPARISION BETWEEN POSITION 1 AND POSITION 2

(TRANS-1 AND TRANS-2)

37

MAGNITUDE OF OVERLAP OF CAROTID ARTERY AND IJV IN

MILLIMETERS(mm)

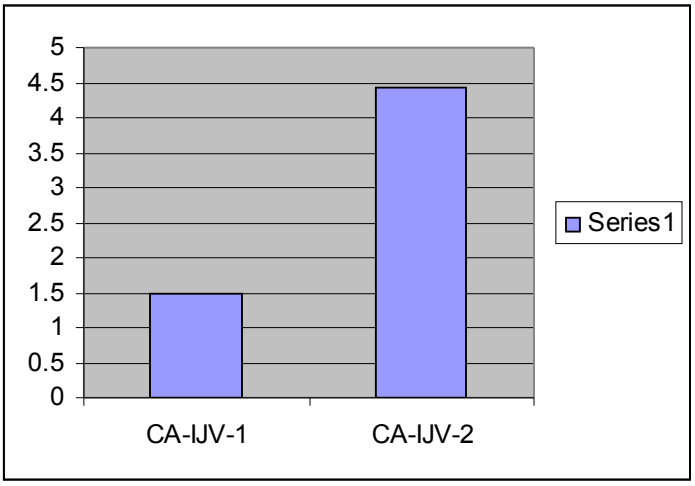
(3) COMPARISION BETWEEN POSITION 1 AND POSITION 2

The mean magnitude of overlap in position 1 was 1.49 mm (standard deviation of 1.96).The mean in position 2 was 4.43 mm (standard deviation

of 2.49).This difference was statistically significant (P value of = 0.000)

MAGNITUDE OF OVERLAP OF CAROTID ARTERY AND IJV IN MILLIMETERS(mm)

(3) **COMPARISION BETWEEN POSITION 1 AND POSITION 2 (CA-IJV-1 AND CA-IJV-2)**



39

DEPTH OF THE IJV FROM THE SKIN IN MILLIMETERS(mm)

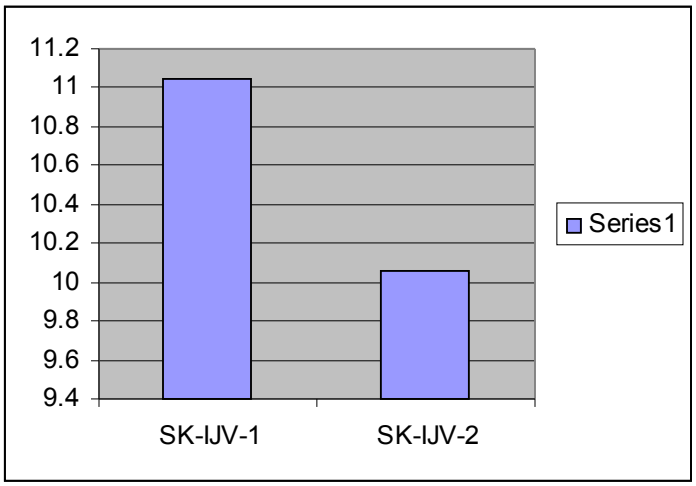
(4) COMPARISION BETWEEN POSITION 1 AND POSITION 2

The mean depth in position 1 was 11.05 mm (standard deviation of 1.88). The mean in position 2 was 10.06 mm (standard deviation of 2.12).This difference was statistically significant (P = 0.001)

DEPTH OF THE IJV FROM THE SKIN IN MILLIMETERS(mm)

(4)COMPARISION BETWEEN POSITION 1 AND POSITION 2

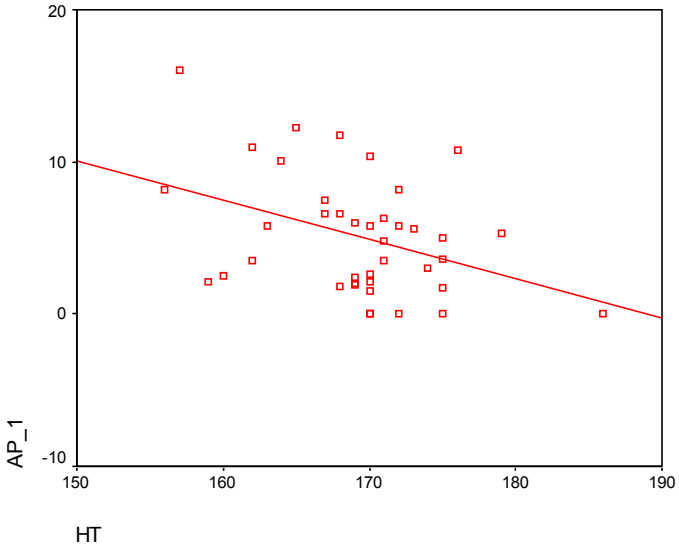
(SK-IJV-1 AND SK-IJV-2)



41

Then we analysed how height, weight, neck circumference and sternohyoid distance correlate with the diameter of the internal jugular vein.

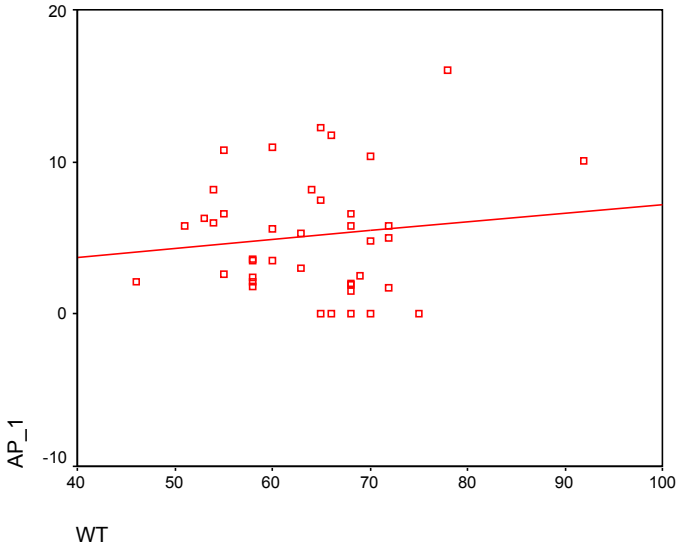
(5) CORRELATION BETWEEN HEIGHT (HT) AND POSITION 1 ANTEROPOSTERIOR DIAMETER (AP-1)



As the graph shows, there was no statistically significant correlation.

(6) CORRELATION BETWEEN WEIGHT (WT) AND POSITION 1

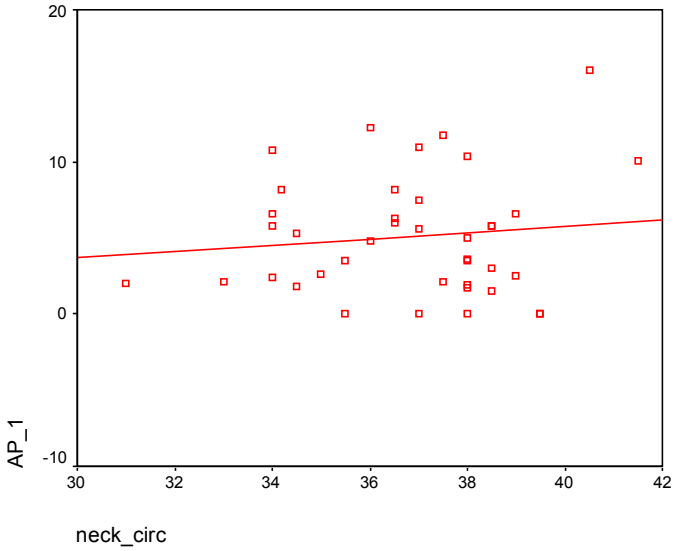
ANTEROPOSTERIOR DIAMETER (AP-1)



As the graph shows, there was no statistically significant correlation.

(7) CORRELATION BETWEEN NECK CIRCUMFERENCE (neck circ)

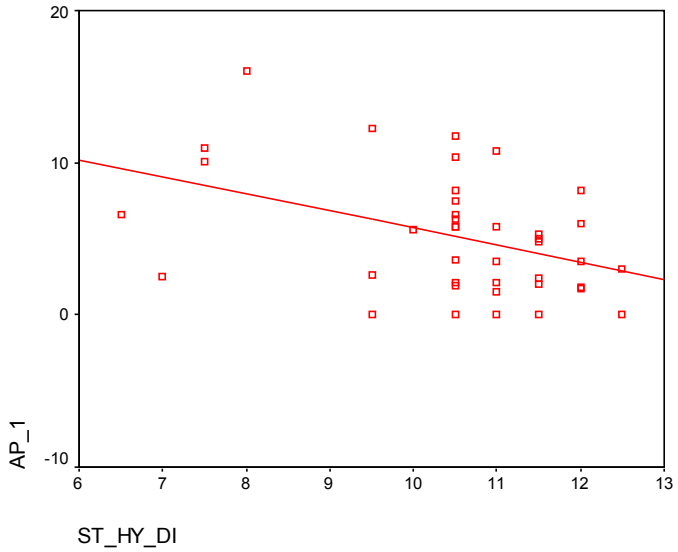
AND POSITION 1 ANTEROPOSTERIOR DIAMETER (AP-1)



As the graph shows, there was no statistically significant correlation.

(8) CORRELATION BETWEEN STERNO HYOID DISTANCE (ST-HY) AND

POSITION 1 ANTEROPOSTERIOR DIAMETER (AP-1)



As the graph shows, there was no statistically significant correlation.

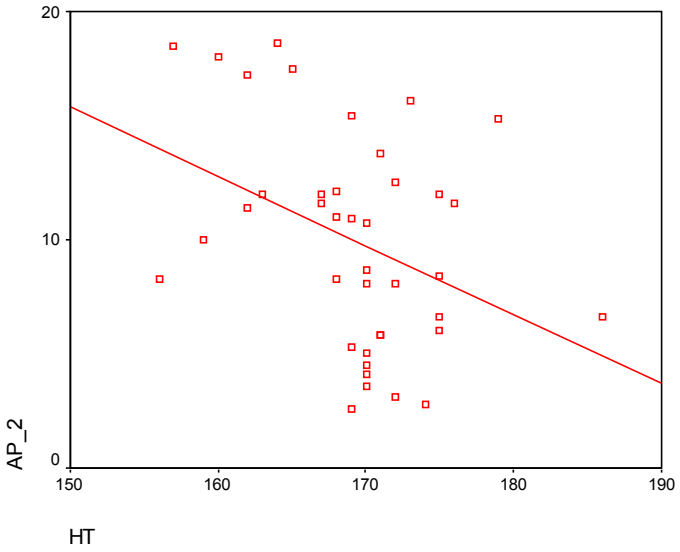
(9) CORRELATION BETWEEN HEIGHT AND POSITION 2

ANTEROPOSTERIOR DIAMETER

The pearson correlation coefficient value (r) was - 0.378 with p value of 0.016 which was statistically significant.

(9) CORRELATION BETWEEN HEIGHT AND POSITION 2

ANTEROPOSTERIOR DIAMETER (AP-2)



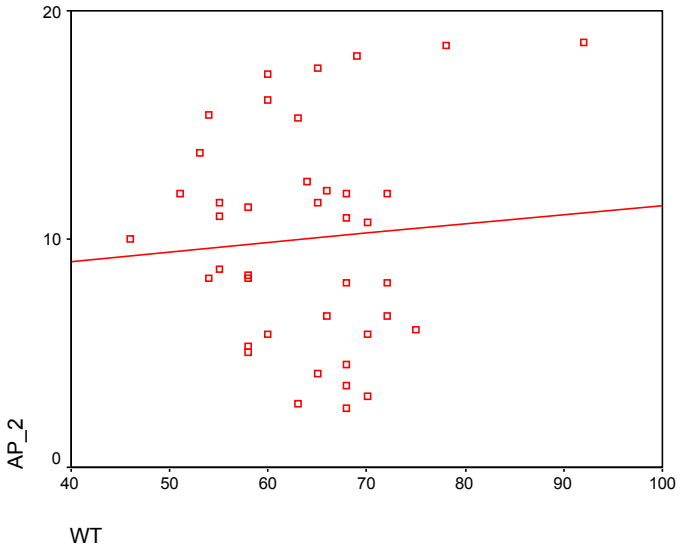
Correlations

		AP_2	HT
AP_2	Pearson Correlation	1	-.378*
	Sig. (2-tailed)	.	.016
	N	40	40
HT	Pearson Correlation	-.378*	1
	Sig. (2-tailed)	.016	.
	N	40	40

*. Correlation is significant at the 0.05 level (2-tailed).

(10) CORRELATION BETWEEN WEIGHT AND POSITION 2

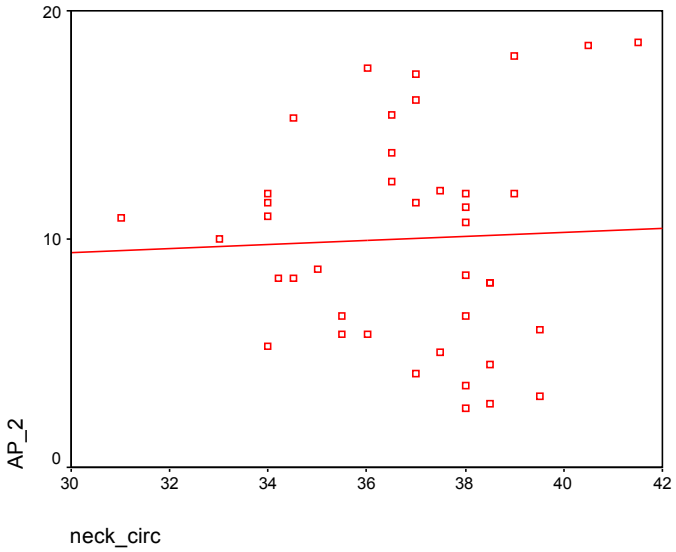
ANTEROPOSTERIOR DIAMETER (AP-2)



As the graph shows, there was no statistically significant correlation.

(11) CORRELATION BETWEEN NECK CIRCUMFERENCE (NECK-CIRC)

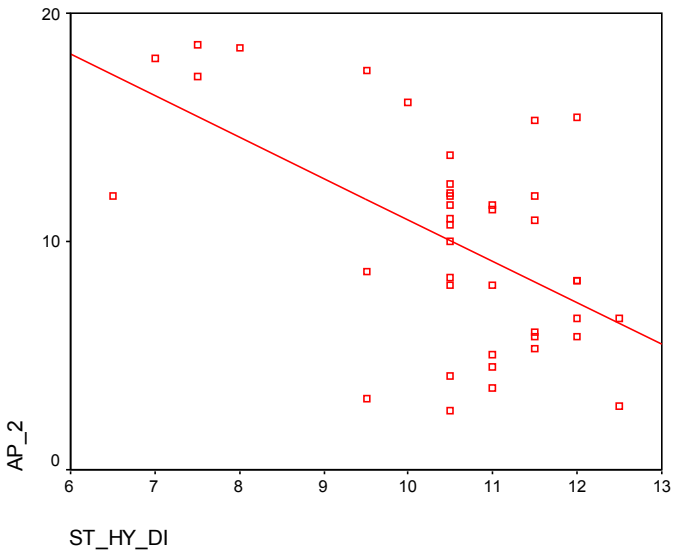
AND POSITION 2 ANTEROPOSTERIOR DIAMETER (AP-2)



As the graph shows, there was no statistically significant correlation.

(12) CORRELATION BETWEEN STERNO HYOID DISTANCE(ST- HY)

AND POSITION 2 ANTEROPOSTERIOR DIAMETER (AP-2)



Correlations

		ST_HY_DI	AP_2
ST_HY_DI	Pearson Correlation	1	-.561**
	Sig. (2-tailed)	.	.000
	N	40	40
AP_2	Pearson Correlation	-.561**	1
	Sig. (2-tailed)	.000	.
	N	40	40

**. Correlation is significant at the 0.01 level (2-tailed).

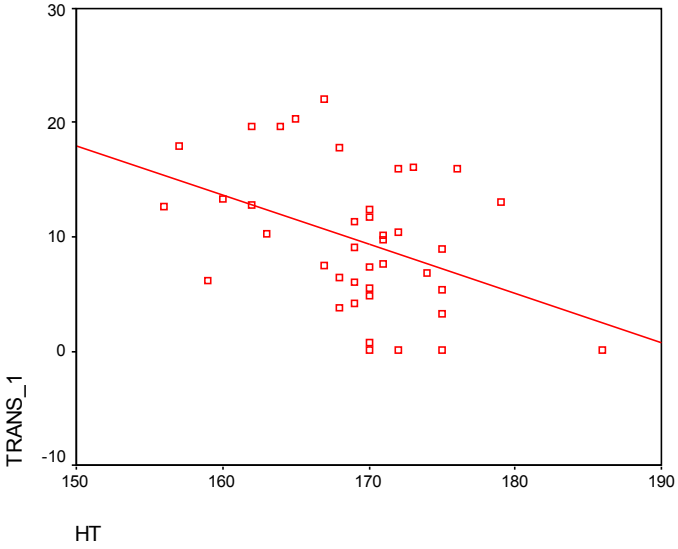
(12) CORRELATION BETWEEN STERNO HYOID DISTANCE AND

POSITION 2 ANTEROPOSTERIOR DIAMETER (AP-2)

The pearson correlation coefficient value (r) was -0.561 with p value of 0.000 which was statistically significant.

(13) CORRELATION BETWEEN HEIGHT AND POSITION 1 TRANSVERSE

DIAMETER (TRANS-1)



Correlations

		HT	TRANS_1
HT	Pearson Correlation	1	-.415**
	Sig. (2-tailed)	.	.008
	N	40	40
TRANS_1	Pearson Correlation	-.415**	1
	Sig. (2-tailed)	.008	.
	N	40	40

**. Correlation is significant at the 0.01 level (2-tailed).

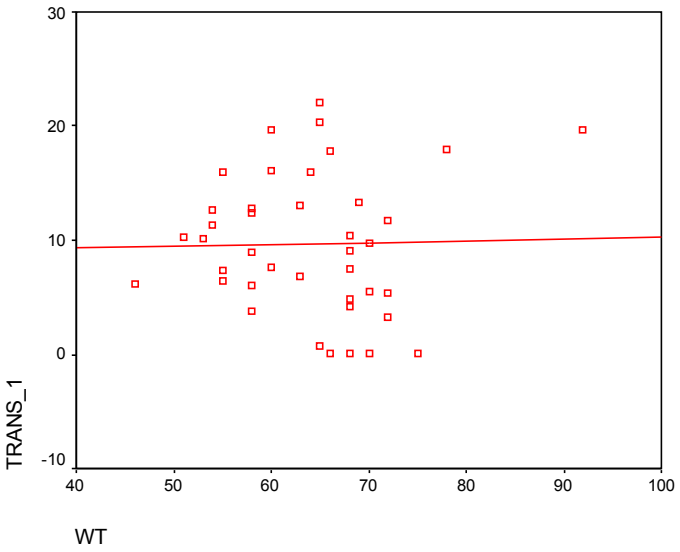
(13) CORRELATION BETWEEN HEIGHT AND POSITION 1

TRANSVERSE DIAMETER (TRANS-1)

The pearson correlation coefficient value (r) was -0.415 with p value of 0.008 which was statistically significant.

(14) CORRELATION BETWEEN WEIGHT AND POSITION 1

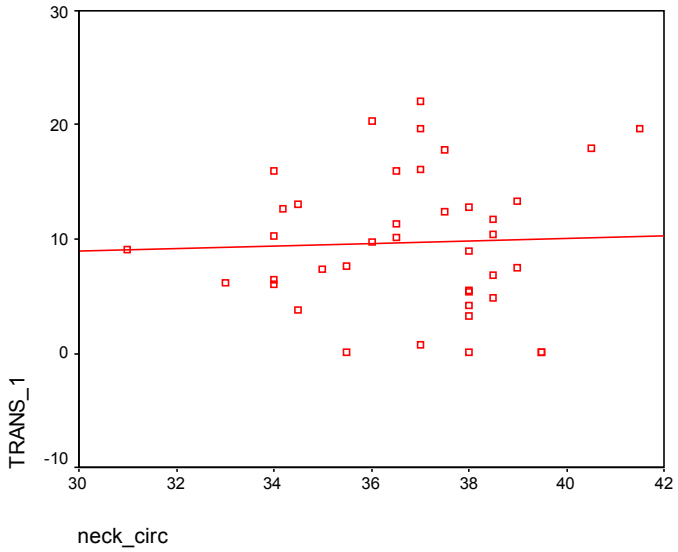
TRANSVERSE DIAMETER (TRANS-1)



As the graph shows, there was no statistically significant correlation.

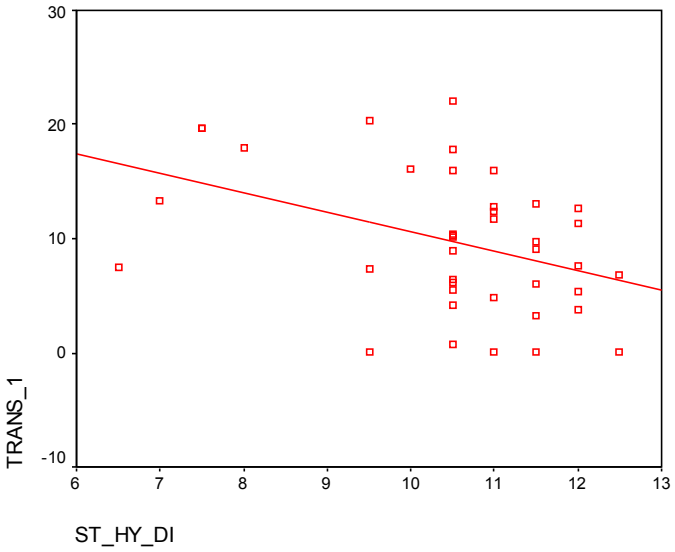
(15) CORRELATION BETWEEN NECK CIRCUMFERENCE AND POSITION 1

TRANSVERSE DIAMETER (TRANS-1)



As the graph shows, there was no statistically significant correlation.

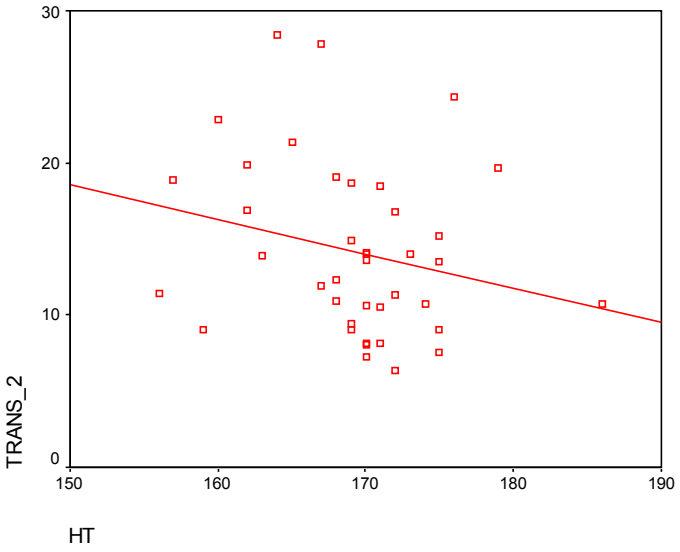
(16) CORRELATION BETWEEN STERNO HYOID DISTANCE(ST-HY) AND POSITION1 TRANSVERSE DIAMETER (TRANS-1)



As the graph shows, there was no statistically significant correlation.

(17) CORRELATION BETWEEN HEIGHT AND

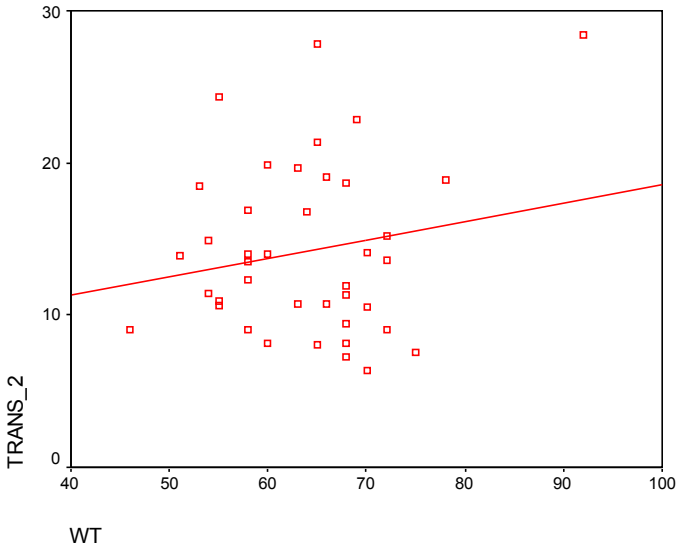
POSITION 2 TRANSVERSE DIAMETER (TRANS-2)



As the graph shows, there was no statistically significant correlation.

(18) CORRELATION BETWEEN WEIGHT AND

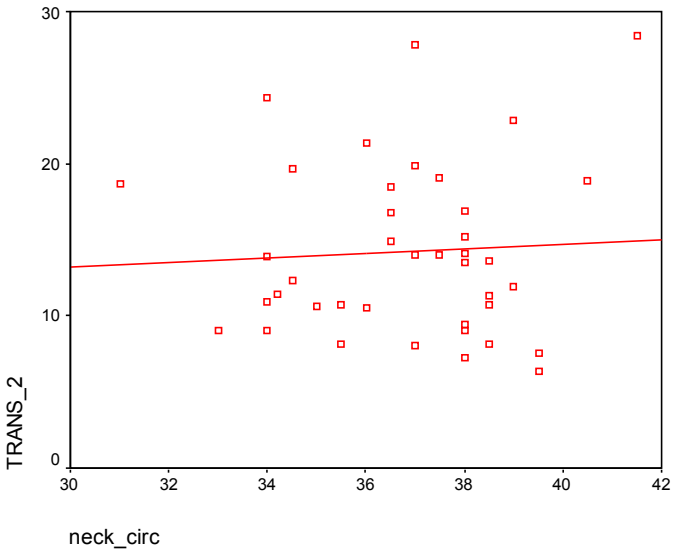
POSITION 2 TRANSVERSE DIAMETER (TRANS-2)



As the graph shows, there was no statistically significant correlation.

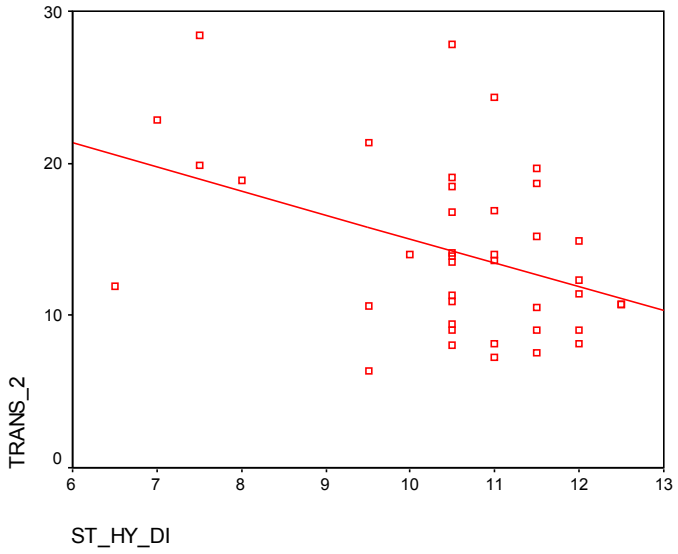
(19) CORRELATION BETWEEN NECK CIRCUMFERENCE(neck-circ)

AND POSITION 2 TRANSVERSE DIAMETER (TRANS-2)



As the graph shows, there was no statistically significant correlation.

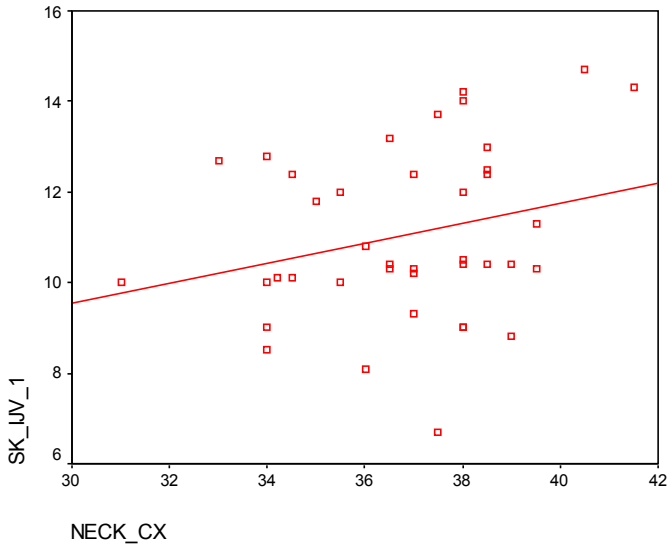
(20) CORRELATION BETWEEN STERNO HYOID DISTANCE(ST-HY) AND POSITION 2 TRANSVERSE DIAMETER (TRANS-2)



As the graph shows, there was no statistically significant correlation.

(21) CORRELATION BETWEEN NECK CIRCUMFERENCE(neck-circ)

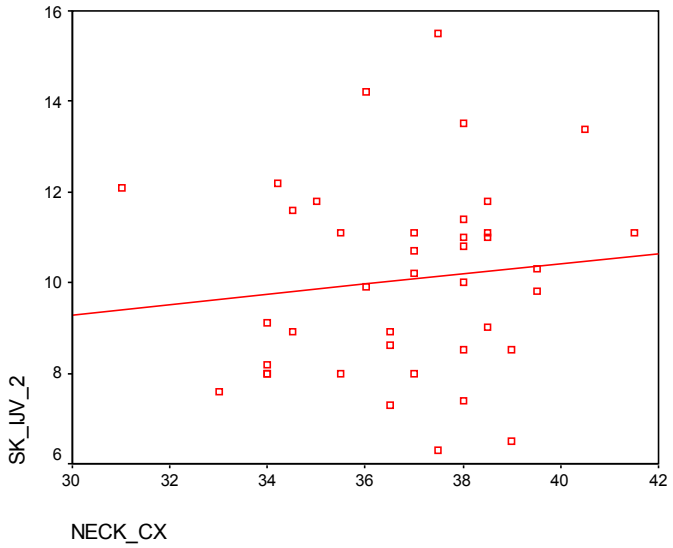
AND DEPTH OF IJV FROM THE SKIN(SK-IJV) IN POSITION 1



As the graph shows, there was no statistically significant correlation.

(22) CORRELATION BETWEEN NECK CIRCUMFERENCE(neck-circ)

AND DEPTH OF IJV FROM THE SKIN(SK-IJV) IN POSITION 2



As the graph shows, there was no statistically significant correlation.

DISCUSSION

Cannulation of the IJV is commonly performed using anatomical landmarks. A variety of techniques and patient positions have been used to access the IJV(1,2,12,14). If a particular technique and patient position results in an increase of the diameter of the IJV, it can be expected that there will be an increase in the chance of first pass cannulation.

As it has been stated that increase in the diameter of the IJV increases the chances of first pass cannulation, we tried to find out in which position the IJV has greater diameter.

Our study reveals that both the antero posterior and the transverse diameters of the IJV are significantly increased in position 2 (Figure 7), that is the modified position.

In modified position (position 2), the elimination of the stretch imparted to the IJV, creation of flexion of the neck and absence of finger palpation could be the primary explanation why this position results in the greater diameter of the IJV.

This increase in diameter should definitely increase the chances of first pass and quick cannulation of the IJV(1).

The relationship of IJV with carotid artery showed that the overlap was more in the modified position in which the head was slightly turned to the contralateral side.

Sulek and collegues have showed greater overlap between the IJV and carotid artery when the head was rotated to 80 degrees compared with 0 degree and 40 degrees(13). But in our study, we found greater overlap in position 2 in which the head was rotated less than in position 1. The significant increase in the diameter of the IJV in position 2 could explain this phenomenon. In their study they have not compared the diameter of the IJV with the overlap.

This has been proved by Troianos et al when they stated that the vein size had positive correlation to the overlap score in their study. Patients with larger veins tended to have greater scores(21).

The IJV is anatomically described classically lateral to the carotid artery. This description is in the coronal plane, not in the directional plane of the cannulating needle with head turned to the opposite side. This is why our study shows the carotid artery is either close to or overlapped anteriorly by the IJV.

Greater overlap could result in the increased incidence of carotid artery puncture during IJV cannulation. For carotid artery puncture to be avoided when there is greater overlap, a posterolateral approach, whereby the IJV is punctured from sideways rather than by a more vertical, perpendicular- to- the- skin approach would be advisable.

This approach has also been referred to Troianos et al. They suggest that a needle directed toward the porition of the vein that does not overlie the CA would have a lower risk of puncturing the CA than a needle directed toward the portion of the vein that overlies the CA. If the cannulating needle enters the IJV and is aimed at the CA, entry in to the IJV may be detected before the needle exits the lumen through the posterior wall of the IJV.

The depth of the IJV from the skin showed significant difference when compared between the two positions. Though it is statistically significant, it may not be clinically significant as the difference was only one millimeter.

Our study was initially proposed to be done with table at 10 degrees head down tilt. The additional information that we picked up in this study was that the conventional position with a 10 degree head down tilt resulted in significant discomfort of heaviness of the head. Hence the head down tilt was reduced to 5 degrees to reduce volunteer discomfort. This must be kept in mind in the actual clinical scenario too.

The head down tilt, excessive head rotation and neck extension all can increase intracranial pressure. This can be dangerous in neurosurgical patients who already have reduced intracranial compliance. Position 2 can reduce this increase in the intracranial pressure by avoiding neck extension and extreme head rotation(22).

When the weight, height, neck circumference and the sterno hyoid distance were correlated with the diameter of the IJV, height showed negative correlation with the anteroposterior diameter of the IJV in the modified position and the transverse diameter in the conventional position. The sterno hyoid distance also showed negative correlation with the anteroposterior diameter in the modified position. It was not possible to comment on these inconsistent findings. Study performed in actual patient population with a wide range of physical parameters including overweight, obese patients may result in different findings.

A study conducted in the Department of Neurology, University Hospital Charite, Schumannstrasse 20/21, D-10098 Berlin, Germany by S.J. Schreiber, U.K.W. Lambert, F. Doepp and J.M. Valdueza about Effects of prolonged head-down tilt on internal jugular vein cross sectional area concludes that the 10 degree head down tilt manoeuvere in healthy volunteers causes an immediate, significant increase in cross sectional area in the right IJV.A longer tilt did not cause further increase in internal jugular vein cross sectional area(2).

To avoid bias in the measurements because of the above phenomenon, it was decided to place the initial twenty volunteers in the conventional position first then to the modified position; The next twenty volunteers in the modified position first then to the conventional position. So that the advantage of immediate increase in the IJV diameter by the head down tilt in any one position could be nullified.

Sample size for this study was calculated after performing a pilot study because of lack of adequate study articles in the literature to contribute to sample size determination.The pilot study included twenty other volunteers.

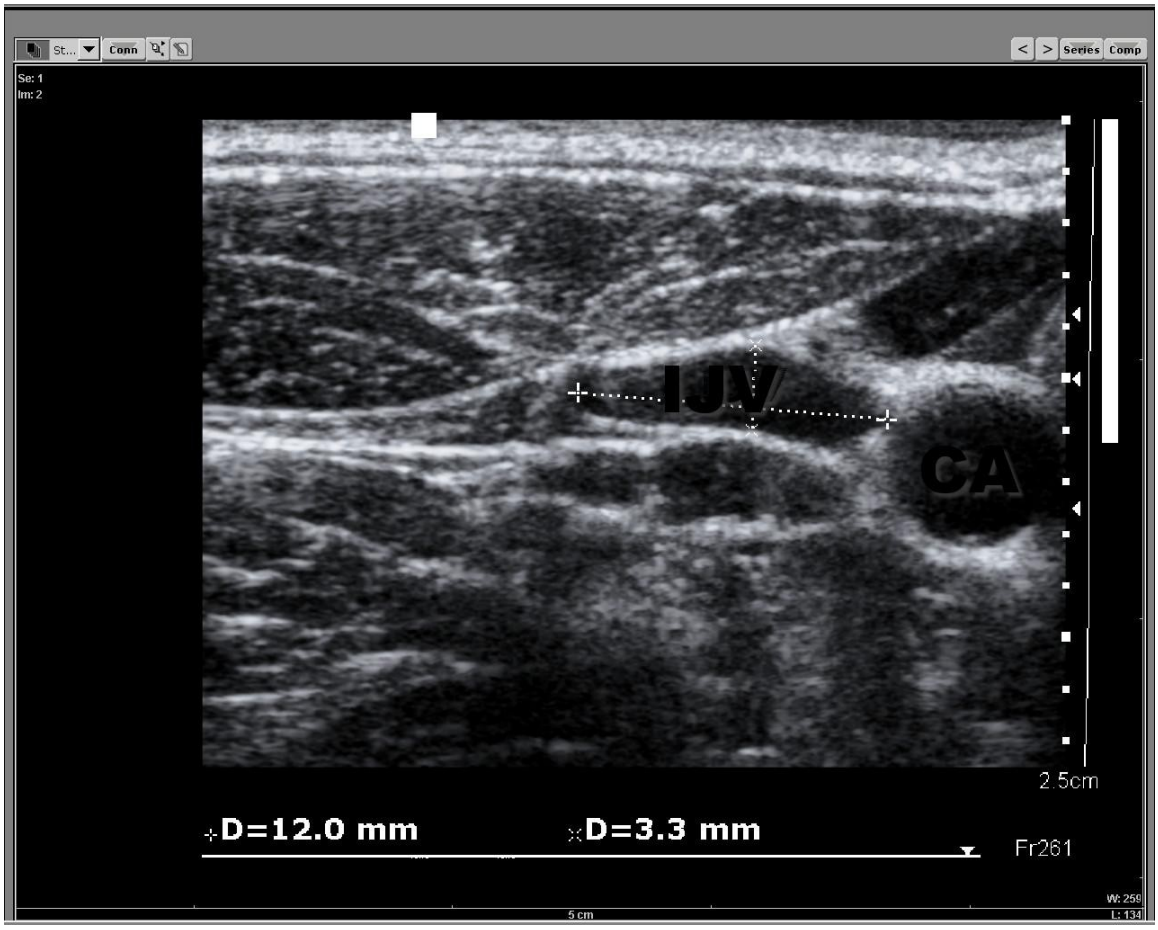
It was initially planned to do the main study in patients who are coming for open heart surgeries in our institution. Since we had practical problems like getting a good ultrasound scanner which can give accurate measurements in millimeters inside the operating room and also getting an experienced unbiased radiologist inside the operating room, it was decided to do the study in volunteers in the radiology department under the supervision of a senior anaesthetist and radiologist.

If the study is performed in a patient population which includes patients with and without cardiovascular diseases coming for cardiac and noncardiac surgeries, the study may be more informative.

Ultrasound guidance has been proven to be superior to the land mark guided cannulation. There is increased success rate, increased rate of first pass cannulation, less number of attempts and avoidance of complications in several randomized, controlled studies.(3,17,22). But in a country like India where the resources are limited, we still have to rely more on the anatomical landmarks for the cannulation, This modified position which increases the diameter of the IJV could be adopted during internal jugular vein cannulation for greater success, particularly in the absence of ultrasound guidance.

FIGURE 6

CONVENTIONAL POSITION

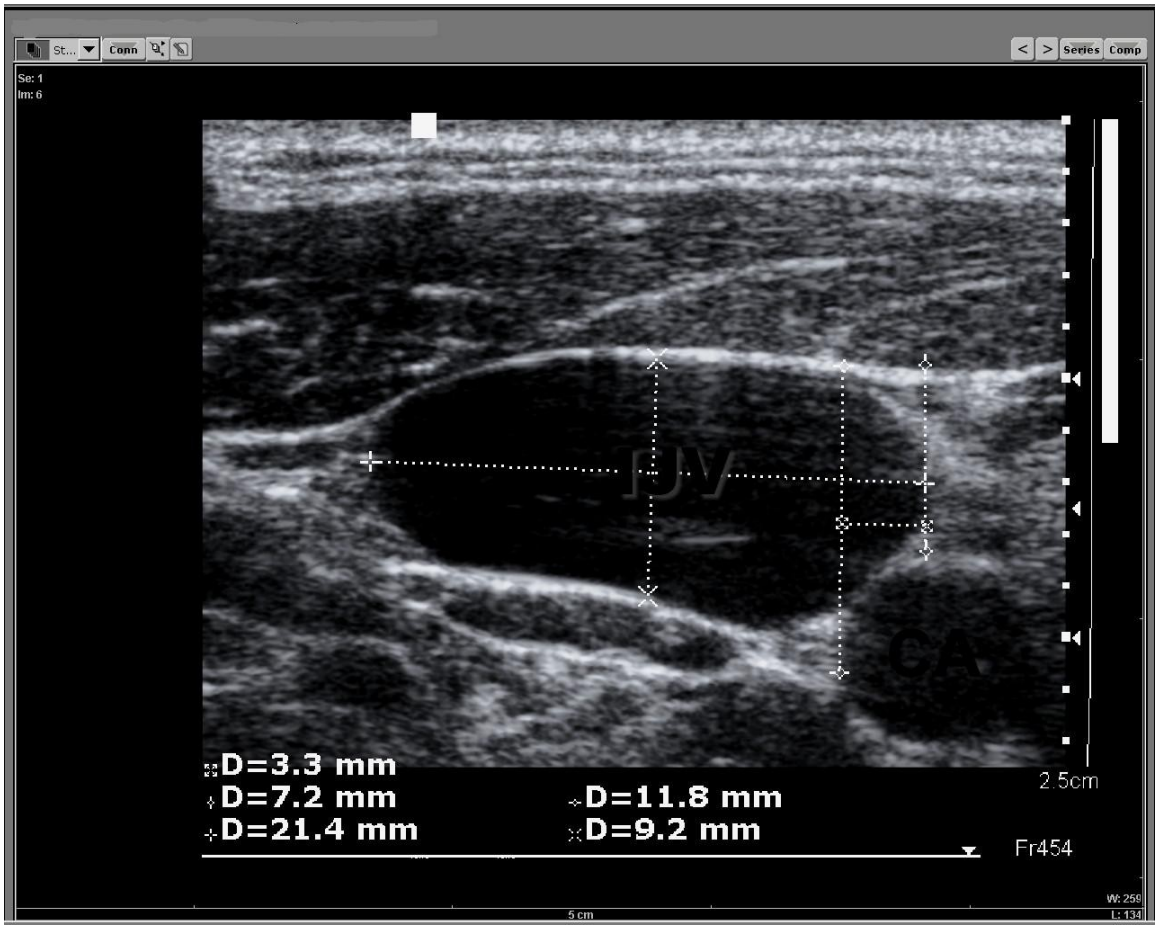


IJV- INTERNAL JUGULAR VEIN

CA- CAROTID ARTERY

FIGURE 7

MODIFIED POSITION



IJV- INTERNAL JUGULAR VEIN

CA- CAROTID ARTERY

CONCLUSION

(1)The antero posterior and the transverse diameters of the right internal jugular vein are significantly greater in the modified position compared to the conventional position. The larger diameter of the internal jugular vein in this modified position can lead to a greater success rate in the cannulation of the internal jugular vein.

(2)Overlap of the carotid artery by the internal jugular vein is greater in the modified position compared to the conventional position. Theoritically this could result in greater incidence of carotid artery puncture if care is not taken.

(3)There is no significant consistant correlation between the height, weight, neck circumference and the sterno hyoid distance with the diameter of the IJV in the population studied.

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APPENDIX

(a)SAMPLE SIZE DETERMINATION

With the help of the statistician, the pilot study data were analysed. Paired 't' test was used for analysis. The anteroposterior diameter of the internal jugular vein showed significant difference in two positions. Using the following formula the sample size of forty was calculated.

$$n = \frac{(Z_{\alpha/2} + Z_{1-\beta})^2 2S^2}{d^2}$$

n-sample size

α- level of significance (0.05)

β- power of the study (0.2)

s- pooled standard deviation

d- difference between the two means

(b)MASTER CHART

ht	*wt*	*age_yrs*	*neck_cx*	*st_hy_di*	*ca_ijv_1*	*sk_ijv_1*	*ap_1*	*trans_1*	*ca_ijv_2*	*sk_ijv_2*	*ap_2*	*trans_2*
186	66	20	35.5	12.5	0	10	0	0	2	8	6.6	10.7
159	46	23	33	10.5	0	12.7	2.1	6.2	5.5	7.6	10	9
176	55	18	34	11	0	10	10.8	16	5.1	9.1	11.6	24.3
171	70	20	36	11.5	3.7	8.1	4.8	9.8	5.2	14.2	5.8	10.5
163	51	22	34	10.5	0	12.8	5.8	10.3	4.7	8	12	13.9
156	54	21	34.2	12	0	10.1	8.2	12.6	1.3	12.2	8.3	11.4
169	68	29	31	11.5	2.4	10	2	9.1	5.7	12.1	10.9	18.7
173	60	21	37	10	0	10.2	5.6	16.1	3.5	11.1	16.1	14
162	58	27	38	11	0	14.2	3.5	12.8	5.6	13.5	11.4	16.9
170	58	26	37.5	11	0	13.7	2.1	12.4	2.1	15.5	5	14
170	55	22	35	9.5	0	11.8	2.6	7.4	5	11.8	8.7	10.6
175	58	28	38	10.5	1.3	14	3.6	9	3.7	11.4	8.4	13.5
171	53	28	36.5	10.5	3.4	13.2	6.3	10.1	10.5	8.9	13.8	18.5
179	63	19	34.5	11.5	0	12.4	5.3	13	6.9	11.6	15.3	19.7
165	65	23	36	9.5	5	10.8	12.3	20.3	8.4	9.9	17.5	21.4
169	54	22	36.5	12	0	10.3	6	11.3	0	7.3	15.4	14.9
172	64	23	36.5	10.5	3.7	10.4	8.2	16	7.5	8.6	12.5	16.8
157	78	29	40.5	8	7.2	14.7	16	18	6.1	13.4	18.5	18.9
164	92	27	41.5	7.5	0	14.3	10.1	19.7	9	11.1	18.6	28.4
162	60	29	37	7.5	3.9	10.3	11	19.7	5.1	10.2	17.2	19.9
160	69	29	39	7	2.1	8.8	2.5	13.3	6.8	6.5	18	22.8
167	65	35	37	10.5	0.9	12.4	7.5	22	6.3	10.7	11.6	27.8
168	66	36	37.5	10.5	5.2	6.7	11.8	17.8	5.9	6.3	12.1	19.1
172	68	29	38.5	10.5	1.3	10.4	5.8	10.4	2.5	9	8.1	11.3
175	72	29	38	12	0	9	1.7	5.3	3	7.4	6.6	9
167	68	29	39	6.5	4.7	10.4	6.6	7.5	5.6	8.5	12	11.9
175	72	33	38	11.5	3.1	9	5	3.3	2.8	8.5	12	15.2
170	70	31	38	10.5	0	12	10.4	5.5	3.8	10.8	10.7	14.1
170	68	29	38.5	11	0	12.4	1.5	4.9	1.7	11.8	4.5	8.1
172	70	29	39.5	9.5	0	10.3	0	0	1	10.3	3.1	6.4
170	65	30	37	10.5	0	9.3	0	0.7	3.9	8	4.1	8
169	68	28	38	10.5	0	10.4	1.9	4.2	0	10	2.6	9.4
170	72	33	38.5	11	1.8	12.5	5.8	11.7	5.9	11.1	8.1	13.6
169	58	37	34	11.5	2.4	9	2.4	6	7.6	8.2	5.3	9
168	58	33	34.5	12	0	10.1	1.8	3.8	1.4	8.9	8.3	12.3
171	60	31	35.5	12	1.7	12	3.5	7.6	1.6	11.1	5.8	8.1
174	63	31	38.5	12.5	1.2	13	3	6.8	6	11	2.8	10.7
175	75	33	39.5	11.5	0	11.3	0	0	2.1	9.8	6	7.5
168	55	35	34	10.5	4.7	8.5	6.6	6.4	3.5	8	11	10.9
170	68	33	38	11	0	10.5	0	0	2.7	11	3.6	7.3

GLOSSARY

ht- height of the volunteer in cms

wt- weight of the volunteer in kgs

age_yrs-age in years

neck_cx-neck circumference at the level of the cricoid cartilage

st_hy_di- sterno hyoid distance

ca_ijv_1-overlap between carotid artery and the IJV in position 1

sk_ijv_1- depth of the IJV from the skin in position 1

ap_1- anteroposterior diameter of the IJV in position 1

trans_1- transverse diameter in position 1

ca_ijv_2-overlap between carotid artery and the IJV in position 2

sk_ijv_2- depth of the IJV from the skin in position 2

ap_2- anteroposterior diameter of the IJV in position 2

trans_2- transverse diameter in position 2

(c)PROFORMA

NAME OF THE VOLUNTEER: **WEIGHT: kgs**

AGE: YRS **HEIGHT: cms**

SEX: Male/Female

DISTANCE FROM THE HYOID BONE TO THE

UPPER BORDER OF THE STERNUM: cms

NECK CIRCUMFERENCE

AT THE LEVEL OF THE CRICOID CARTILAGE: cms

IJV DIAMETER (mms)

CONVENTIONAL POSITION (1)		**MODIFIED POSITION (2)**	
ANTEROPOSTERIOR	**TRANSVERSE**	**ANTEROPOSTERIOR**	**TRANSVERSE**

DISTANCE FROM THE COMMON CAROTID ARTERY: mms

DEPTH OF THE INTERNAL JUGULAR VEIN FROM THE SKIN: mms

(d) INFORMATION TO THE VOLUNTEER AND CONSENT FORM

INTRODUCTION

I am Dr.Shenbagarajan, doing my M.D (Anaesthesia) in the department of Anaesthesia, Christian Medical College, Vellore. We are conducting a study that would help in the central line placement which is used to monitor the central venous pressure, to transfuse fluids and to give drug infusions mainly in the major surgeries. The procedure will be done in the Radiology department in the presence of senior Anaesthetist and senior Radiologist.

STUDY PROCEDURE

There are various positions to place the patient for the internal jugular vein cannulation. We are comparing the conventional position with a modified position.

CONVENTIONAL POSITION

-head down tilt

-folded sheet under the shoulder

-head turned completely to the contralateral side

-extension of the neck by removing the intubation pillow

-fingers over the carotid artery region during

measurement

MODIFIED POSITION

-head down tilt

-no folded sheet under the shoulder

-head turned slightly to the contralateral side

-flexion of the neck by keeping the intubation pillow under the head

FIRST GROUP

(1)The volunteer will be positioned in the conventional position

The anteroposterior, transverse diameters of the internal jugular vein, the portion of the carotid artery overlapped by the internal jugular vein and the depth of the internal jugular vein from the skin will be measured using the ultrasound imaging.

(2)The volunteer will be changed to the modified position

The anteroposterior, transverse diameters of the internal jugular vein, the portion of the carotid artery overlapped by the internal jugular vein and the depth of the internal jugular vein from the skin will be measured using the ultrasound imaging.

SECOND GROUP

(1)The volunteer will be positioned in the modified position

The anteroposterior, transverse diameters of the internal jugular vein, the portion of the carotid artery overlapped by the internal jugular vein and the depth of the internal jugular vein from the skin will be measured using the ultrasound imaging.

(2)The volunteer is will be changed to the conventional position

The anteroposterior, transverse diameters of the internal jugular vein, the portion of the carotid artery overlapped by the internal jugular vein and the depth of the internal jugular vein from the skin will be measured using the ultrasound imaging.

In the conventional position we will be pressing your neck to palpate the artery, just like your doctor feels for the pulse in your hand. We will not do any invasive procedure.

BENEFITS

By this study, we may find out in which position the internal jugular vein has greater diameter and it is away from the carotid artery so that it will help us to position the patient for the internal jugular vein cannulation and to avoid accidental carotid artery puncture.

DISCOMFORTS AND RISKS

You may feel a slight discomfort when lying in head down position. It has been proved that ultrasound imaging does no harm to the patients.

COMPENSATION

You need not pay any money for the above procedure. Though complications are unexpected, if any arise, medical care will be given free of cost.

CONFIDENTIALITY

Your name will not appear in the study records. Information related to you will be marked in the code sheet, and only the study doctor will be able to link your name with the code number.

PARTICIPATION IN THE STUDY

Your participation in this study is entirely voluntary and you have the right to refuse to volunteer from this study. If you volunteer, you are required to sign in the following consent form.

CONSENT

I have read this consent form and have discussed the procedure with Dr.Shenbagarajan. The details of this study have been explained to me. I have been given the opportunities to ask questions which have been answered to my satisfaction. I understand that this study is voluntary. I understand that I may refuse to participate in this study at any stage .I give my consent to be enrolled in this study.

SIGNATURE OF THE ANAESTHETIST:

SIGNATURE OF THE PARTICIPANT:

NAME OF THE PARTICIPANT:

DATE: